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DEVELOPMENT OF AGRICULTURE PRODUCTION AND AGROBUSSINES IN CLIMATE CHANGE CONDITIONS IN SERBIA AND NEIGHBOR REGION

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Abstract: Agribusiness in Serbia, the region, and Southeastern Europe faces significant challenges due to climate change and shifting market conditions. The aim of this paper is to analyze the impact of climate change on agricultural production and the supply/demand of agricultural products at the regional and European levels, as well as to explore strategies for agribusiness adaptation to new market and climate conditions. The materials and methods include an analysis of market data, climate trends, and relevant agricultural policies. The main findings indicate that agribusiness must adopt sustainable practices and innovations to remain competitive in changing conditions. The conclusion is that adapting to these challenges requires the integration of new technologies, improvement of agricultural methods, and cooperation with European markets to ensure the sector's sustainable future.

Keywords: Agribusiness, Climate change, Sustainability, Innovation, Adaptation

1. INTRODUCTION

Climate change, driven by natural cycles and anthropogenic activities, poses an increasing risk to agricultural production, the supply and demand of agricultural products, both at the regional and European levels. Climate change disturbs the agro-ecosystem, due to changes in weather conditions such as temperature, precipitation, and sunlight, while further influencing the arable, livestock, and hydrology sectors. The impact of climate change on arable lands expressed in changes of agricultural production related to change of efficiency flowering, fertilisation, harvesting time (Young-Eun et al., 2007). Although it is challenging to predict all consequences with certainty, research indicates a growing frequency and intensity of extreme weather events, such as droughts, heavy rainfall, and floods, which directly affect yields, product quality, and the economic stability of the agricultural sector (Stričević et al., 2021).

In Serbia, these effects are particularly pronounced, with increasingly frequent extreme climate events significantly impacting crops and local economies (Mihailović et al., 2015). Yield losses, rising production costs, and market price fluctuations further complicate producers' efforts to adapt to new conditions.

Addressing these challenges requires the development and implementation of strategies for adapting agribusiness to new climate and market conditions. Key measures include optimizing irrigation, introducing more resilient crop varieties, improving storage capacities, and enhancing the connection between local producers and regional and European markets (Jančić et al., 2015; Starčević et al., 2018). Additionally, attention must be directed towards building resilience across

the entire supply chain, with the support of local authorities, policymakers, and international partners.

This paper analyzes the impact of climate change on agricultural production and the agricultural product market, exploring adaptation strategies for agribusiness to achieve sustainable development and competitiveness at the regional and European levels.

2. RESEARCH METHODOLOGY

The methodology applied in this paper follows the structure of a review article, synthesizing existing knowledge and data on the impact of climate change on agriculture in Southeastern Europe and Serbia. It combines quantitative and qualitative approaches to analyze secondary data collected from reliable sources such as Eurostat, FAO, and national statistical agencies. A systematic review of academic and institutional literature was conducted to examine agricultural production trends, economic indicators, and adaptation strategies.

Statistical data were analyzed to provide a comprehensive overview of agricultural conditions, including comparative analysis of different countries in the region to identify patterns and differences in responses to climate change and market challenges.

Historical and projected climate data were used to assess trends in temperature, precipitation, and their impact on agricultural yields. Key issues such as water scarcity, extreme weather events, pest outbreaks, and soil fertility degradation were identified and analyzed to understand their influence on agriculture.

Although no primary interviews were conducted, qualitative insights from existing studies and reports involving farmers, policymakers, and climate experts were integrated to add depth and context to the analysis. This approach ensures that the research is based on robust evidence, offering valuable insights and recommendations for adapting agricultural practices in Southeastern Europe and Serbia to the challenges posed by climate change.

3. CHARACTERISTICS OF AGRICULTURE, CLIMATE AND AGRIBUSINESS IN SERBIA, REGION AND SOUTHEAST EUROPE

3.1. Structure and dynamics of agriculture in the region and SE Europe

Agriculture holds a significant role in the economies of Southeastern European countries, contributing 7-10% to their gross national income, depending on each country’s specific economic and structural conditions. For instance, Serbia's agricultural sector employs around 20% of the population, while neighboring countries such as Croatia and Bosnia and Herzegovina have slightly higher shares, with family farms dominating production (Eurostat, 2023). In Croatia, over 150,000 agricultural households were registered in 2023, with 99% being family farms averaging 6 hectares in size (National Statistical Agency, 2023). Bosnia and Herzegovina face similar challenges, such as land fragmentation, outdated cultivation practices, and increasing vulnerability to climate change, notably droughts and floods. These climate impacts, particularly for staple crops like corn and wheat, are expected to reduce yields (FAO, 2022).

Regional challenges include systemic barriers such as fragmented land holdings and outdated infrastructure, which hinder adaptation to new climatic conditions. In 2024, total yields are expected to decline due to unfavorable weather patterns (Eurostat, 2023). To address these issues, regional countries are focusing on modernizing agriculture with sustainable practices and infrastructure improvements, with key data provided by Eurostat, FAO, and national statistical agencies (Eurostat, 2023; FAO, 2022)

3.2. Structure and dynamics of agriculture in Serbia

Agriculture is crucial for Serbia's economy, contributing about 6-6.8% to its gross national income between 2015 and 2017. The sector is predominantly composed of small family farms, with approximately 631,552 households and 1,442,628 workers, making up about 20% of the population (Statistical Office of the Republic of Serbia, 2023). The average farm size is relatively small, at 5.4 hectares, often spread across multiple plots, which increases vulnerability and hinders sector development (Statistical Office of the Republic of Serbia, 2023). Preliminary data from the 2023 Agricultural Census reveals that 99.6% of the 508,365 registered farms are family-owned, averaging 6.4 hectares, typically involving livestock such as cattle, pigs, sheep, poultry, and beehives (Statistical Office of the Republic of Serbia, 2023).

Climate change, including droughts, is expected to cause a decline in crop yields in 2024, particularly for corn, soybeans, and sunflowers, which could negatively affect livestock production and overall GDP (Eurostat, 2023; FAO, 2022). Serbia's diverse terrain supports different forms of agriculture: flatlands for crops and vegetables and hilly regions for fruit cultivation. However, to build resilience and improve productivity, adaptation to climate change and improved cultivation practices are essential. Full data from the 2023 census will be published in 2024 (Eurostat, 2023).

3.3. Impact of climate change on agribusiness in Serbia and the region

Climate change is severely affecting agriculture in Serbia and Southeastern Europe. Rising global temperatures and increasing frequency of extreme weather events such as droughts and floods are disrupting food production, market structures, and the economic stability of the agricultural sector. According to the FAO, climate change is expected to reduce yields for staple crops like wheat, corn, and soy, worsening food security in the region (FAO, 2022). Between 2020 and 2022, adverse weather led to declines in cereal production, with predictions of a 10-20% decrease in crop yields by 2030 (Petrović, 2021).

Traditional agricultural practices in Southeastern Europe are largely ill-equipped to handle these challenges. The European Commission has found that many farms lack modern adaptation strategies, exacerbating vulnerability to climate disruptions (EC, 2023). Contributing factors include limited financial resources, lack of access to knowledge and training, and weak infrastructure. Beyond production, climate change also affects broader socioeconomic factors. For instance, rural-to-urban migration is expected to increase as farmers face lower incomes and fewer job opportunities (Marković and Janković, 2022), adding pressure on urban areas and potentially leading to social instability. To mitigate these effects, adopting sustainable agricultural practices and innovations is vital. This includes using climate-resilient crop varieties, precision agriculture, and efficient water resource management (Ristić and Petković, 2023). The EU's Common Agricultural Policy (CAP) provides a framework of financial and technical support to help farmers transition to sustainable practices (EU, 2022). However, urgent action, innovation, and collective support are needed to ensure long-term agricultural stability and sustainability.

3.4. Agribusiness in Serbia, the region, and SE Europe: Adapting to changing market and climate conditions

Soil fertility is a critical challenge for agriculture in Serbia and the broader region, where rising temperatures and unpredictable rainfall patterns lead to soil degradation. FAO reports that declining soil fertility could severely hinder agricultural economic development in Southeastern Europe (FAO, 2022). Adapting farming practices to address these challenges is crucial, especially through sustainable land management practices like crop rotation and organic methods (Biočanin, 2021). These strategies help maintain soil fertility and build resilience against climate change.

A holistic approach is required, encompassing education, training, and the adoption of innovative technologies to improve production capacity and adaptability (Ninković, 2020). Additionally, cooperation among academia, government, and the private sector is vital for developing strategies to address climate change and market challenges, ensuring the agricultural sector's sustainability.

4. CLIMATE CHANGE AND RISK IN AGRICULTURE AND AGRIBUSSINES

4.1. Specific risks for agriculture in SE Europe and Serbia

4.1.2. Water scarcity

Climate change will significantly affect water availability, with reduced summer rainfall expected in Serbia and southern parts of Southeastern Europe. This will lower annual water supplies for irrigation, particularly in regions like Vojvodina and central Serbia, which rely heavily on irrigation. Farmers must expand irrigation systems and improve water efficiency to maintain stable production (Ministry of Agriculture, Forestry, and Water Management, 2023).

4.1.3. Extreme weather events

Extreme weather events, including heatwaves, droughts, and intense rainfall, are expected to increase. In Serbia and parts of Southeastern Europe, drought risks will rise, while central and northern regions may face more frequent floods. These events threaten agricultural production and food security (FAO, 2022).

4.1.4. Increased pest issues

Climate change will facilitate the spread of pests and diseases in crops. Serbia’s farmers will need to manage pest outbreaks within the framework of EU pesticide regulations, which may limit pesticide use and further impact yields (FAO, 2022).

4.1.5. Impact on crop yields and distribution

Climate change will shift agro-climatic zones northward, affecting crop yields and distribution in Serbia. This shift is expected to increase price volatility and income risks for farmers, while agricultural producers outside the EU will also face similar challenges (FAO, 2022).

4.2. Impact of climate change on supply and demand in agribusiness

Climate change affects supply and demand in the agricultural markets of Serbia and Southeastern Europe. Reduced soil fertility and unpredictable production conditions lead to lower supply and higher prices, potentially making food less accessible to consumers (Pajić, 2021). Moreover, changing consumer demands for sustainably sourced and organic products present challenges for conventional producers (Milenković, 2022).

In this context, producers must adjust to new consumer trends and market conditions. Reduced agricultural yields may lead to higher prices for staple foods, prompting consumers to seek substitutes. These shifts require agribusinesses to adapt through diversification and the adoption of innovative technologies to stabilize supply and meet demand (Jovanović, 2020). To cope with these changes, adaptive strategies, innovation, and research are essential for strengthening the agricultural sector's resilience in the face of climate change.

5. EFFECT OF CLIMATE ON AGRICULTURE AND AGRIBUSINESS

On the base of data from 1990 to 2023 the number of agricultural households is decreasing year reflecting migration to urban areas and changes in agricultural practices, and that arable land

gradually decreasing, which, also, may be caused by urbanization, land degradation, and climate change. Due to this changes the percentage of the Working-Age Population in Agriculture is change and continuously decreasing, indicating reduced interest in agriculture as a source of income (Table 1).

Table 1. Agricultural holdings, working-age population and arable land area in Serbia (National Statistical Office of Serbia, 2023)

Year	Number of Agricultural Households	Arable Land (hectares)	Percentage of the Working-Age Population in Agriculture
1990	1.400.000	3.500.000	30%
2002	1.200.000	3.200.000	23%
2008	908.102	2.900.000	18%
2012	562.856	2.800.000	14%
2023	508.365	2.800.000	14%

During the long-term period the average yield of edible plant species varied depend of year cultivated genotypes and their inteaction. The analysis of maize yield in Serbia, from 1990 to 2023, showed variation between 3.8 t ha^{-1} and 7.5 t ha^{-1} (Figure 1).

The yield in the 1990s was around 5.6 t ha^{-1}, but drought years like 2007 and 2012 led to drastic declines (3.8 t ha^{-1} and 2.5 t ha^{-1}, respectively). On the other hand, more favorable weather conditions in 2018 allowed for a yield increased to 7.5 t ha^{-1}, partly due to the introduction of more resilient varieties and modern technologies. The trend line clearly shows fluctuations in yields. Declines are visible in years of intense droughts (2007, 2012), while occasional recoveries in yields (like in 2018) show adaptation through technologies and agronomic measures (Figure 1).

The declines in yields are linked to extreme weather events, such as droughts and heatwaves, while the increase in yields in certain years is a result of investments in more resilient varieties and better agricultural practices.The percentage decrease in yields during drought years, such as 2002 and 2012, underscores the importance of adaptation to climate change, while the yield increases in years with better weather conditions show the potential for improving agricultural productivity (Figure 1).

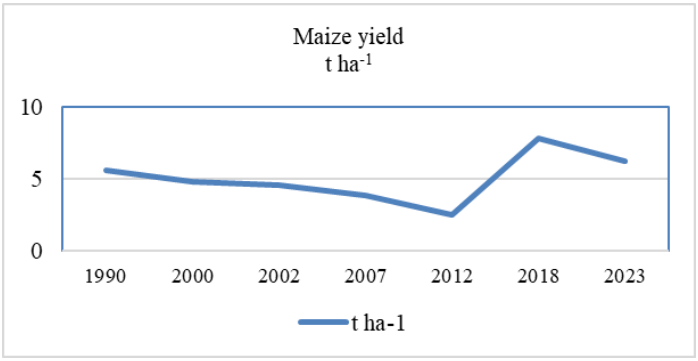

Figure 1. Variation of maize yield in long-term period (National Statistical Office of Serbia, 2023)

Although climate change generally has a negative impact on agricultural yields, there are opportunities for adaptation through innovation and investments in agricultural systems**.** In analysis of wheat yields in Serbia and Southeast Europe during the period 1990-2023 showed variability due to the impact of climate change, particularly droughts, on wheat production (Figure 2).

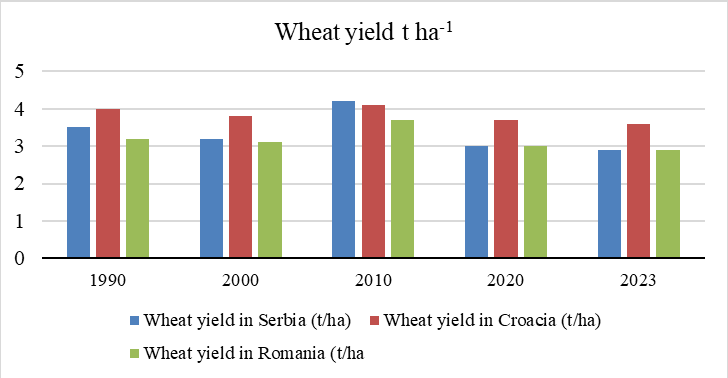

Figure 2. Variation of wheat yield in Serbia, Croatia and Romania (FAO, 2022)

In 1990s to Early 2000s,the wheat yelds were relatively stable, but fluctuations became more noticeable in the early 2000s, linked to changes in weather conditions. A major drought hit the region, occured in 2007. year leading to a significant decline in wheat production, marking one of the biggest drops on the graph. Another sharp decline in yields, occured in 2012. year again due to an extreme drought that affected the region, especially Serbia, Bulgaria, and Romania.Wheat yields show a slight recovery in some years, in period 2015-2023, but droughts in 2022 and 2023 led to reduced yields again (Figure 2). This segment of the graph emphasizes the challenges farmers face due to increasingly frequent drought periods. This analysis underscores the vulnerability of wheat production to climate extremes and the need for adaptive strategies. The variability in wheat yields in relation to drought years, indicate that climate change, particularly droughts, has become one of the main factors affecting agricultural production in Serbia and Southeast Europe. It also suggests the need for strategic adjustments in farming practices to mitigate the damage caused by droughts, such as introducing more drought-resistant wheat varieties and improving irrigation systems. These measures can help adapt to the increasing frequency of extreme weather events, ensuring more stable production despite the challenges posed by climate change.

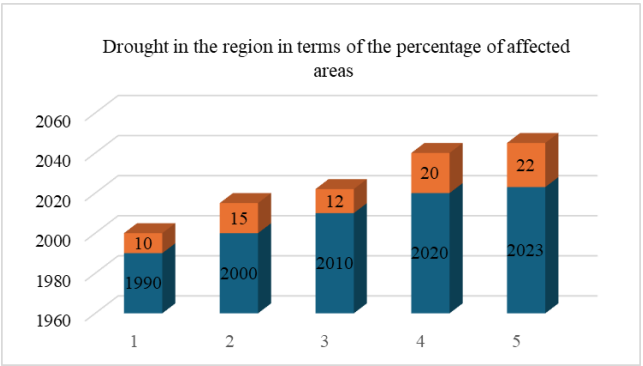

Figure 3. Share of areas affected by drought in the period from 1990 to 2023 (FAO, 2022)

The impact of agricultural areas affected by drought, was different within research period, that increased in long term period from 1990 to 2023 with expression extreme weather conditions and the reduction in arable land (Figure 3). During the early period (1990-2000) showed in the first part of the chart, the percentage of affected areas was below 10-15%. Droughts were less pronounced and rare (Figure 3). During the period 2000-2010 a gradual increase is seen, peaking in 2007, when over 20% of areas were affected by drought (Figure 3). In the last decade (2010-2023) the drought become more severe, with notable impacts in 2012 and 2022, when more than 20% of arable land was affected. The year 2023 continues this trend, confirming that climate change has become a persistent threat to agricultural yields. (Figure 3). The data show a continuous increase in areas affected by drought from

1990 to 2023, highlighting key challenges faced by farmers in Serbia and Southeastern Europe (Figure 3). This trend underscores the urgent need for strategic adjustments, such as more efficient irrigation, the introduction of drought-resistant crop varieties, and better water resource management. In the context of previous texts, this chart further illuminates the interdependence between climate change and the decline in agricultural yields, particularly in regions frequently hit by droughts.

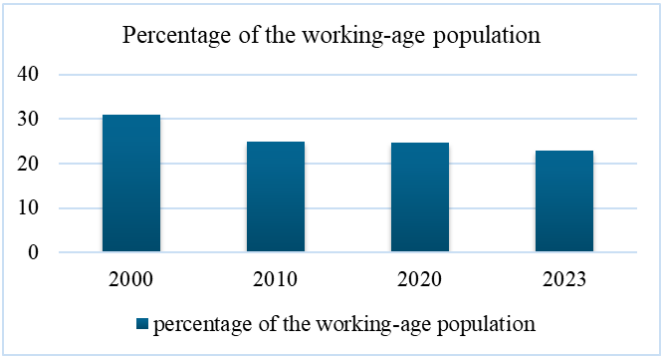

Figure 4. Variation of percentage number of working-age population (FAO, 2022)

The percentage of the working-age population over several years, from 1990 to 2023 varied during the long term period of study (Figure 4). In 1990, the percentage of the working-age population was 37%. This indicates a relatively higher proportion of people in the workforce at that time. In 2000, the percentage dropped to 31%, showing a decline in the working-age population over the decade. The percentage further decreased to 25%, in 2010, the continuing the trend of a shrinking workforce. In 2020, the percentage slightly decreased to 24.6%, showing a minimal decline in the workforce participation rate compared to 2010. The percentage in 2023 reached 23%, indicating an ongoing decline in the working-age population (Figure 4). Overall, the data show a steady decrease in the percentage of the working-age population over the past few decades. This could be due to factors like aging populations, lower birth rates, or changes in economic conditions.

6. CONCLUSION

Based on the analysis of agribusiness in Serbia, the region, and Southeastern Europe, it is clear that we are facing challenges arising from climate change and fluctuating market conditions. Adapting to these changes requires a comprehensive approach that includes innovations, sustainable practices, and collaboration among all sector participants. It is important to develop strategies in the coming period that will allow agribusiness to remain competitive in the European market, while simultaneously preserving natural resources and safeguarding local communities. Through the implementation of modern technologies, farmer education, and strengthening market infrastructure, Serbia can achieve sustainable agribusiness development. Cooperation with regional and European partners, as well as support from government institutions, plays a key role in this transition. Only through joint efforts can we ensure a prosperous future for agribusiness that will be more resilient to climate change and market fluctuations.

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